

## Test Method

# Vacuum Plasma Desmear Uniformity Measurement for Rigid and Flex Printed Circuit Boards

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### 1. SCOPE

An Industry Standard method of determining the desmear uniformity results in large batch plasma machines.

### 2. PURPOSE

The method describes the procedure for measuring the uniformity of rigid, rigid-flex, and flex panels that have been desmeared in a vacuum plasma machine. It is applicable for both users and suppliers to determine desmear results.

### 3. EQUIPMENT (as required for each method)

- 3.1 Weight loss – scale, 4 decimal point, and weight in grams or equivalent
- 3.2 Micro section- potting, grinding, polishing. metallographic microscope.

### 4. TERMS

- 4.1 Carrier Panel- panel used to hold the samples during plasma processing
- 4.2 Cell- Area between 2 electrodes where the panels are treated.
- 4.3 Dummy panel- panels with drilled holes, used to fill the remaining cells after carrier panels are loaded.
- 4.4 Uniformity- Amount of variance within a cell and cell to cell expressed in percent. Percent Uniformity is used when the average value is large relative to the data set range. The larger the value, the better the uniformity. It is calculated using the average, maximum, and minimum values in the data set from the following formula:

$$\text{Percent Uniformity (\%)} = [1 - ((\text{Maximum Value} - \text{Minimum Value}) / (2 * \text{Mean}))] * 100$$

- 4.5 Relative Uniformity – Amount of variance within a cell and cell to cell expressed as a whole number. Relative Uniformity is used when the average value is small relative to the data set range. The larger the number, the better the uniformity. It is calculated using the average and standard deviation from the data set using the following formula:

$$\text{Relative Uniformity} = (\text{Average}) / (\text{Standard Deviation})$$

- 4.6 Validation - Verification that the plasma process was successful for desmear or etchback.

## 5. SAMPLES

### 5.1 Method 1- Weight Loss (Standard method)

Material: RCC (resin coated copper) or equivalent. Reinforcement in the resin is not acceptable.

Size: 3" X 3" (76mm)

Thickness: 0.062" +/- 0.010" (1.6mm)

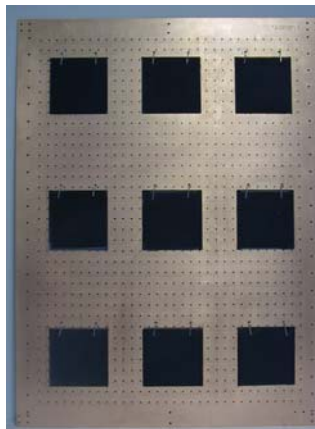
Tooling Holes: 0.125" (3.2mm) 2 per sample and 2 per window in the carrier panel (For vertical processed panels only).

Quantity: 9 per carrier panel.

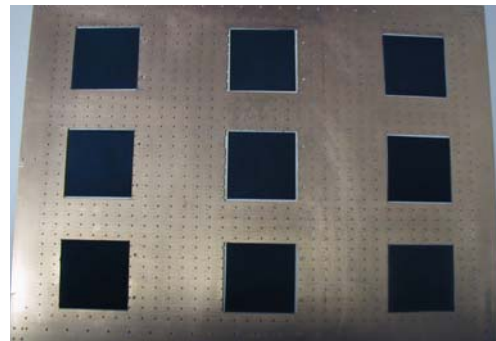
5.1.1 Loading (see fig 1): Each sample is placed in a copper clad carrier panel of the same thickness as the sample. Samples processed in a vertical position are held in the carrier panel using the tooling holes with a small piece of wire. Samples processed horizontally are nested in the carrier panel windows. Carrier panel sizes are determined by the electrode size. Carrier panels can be 2 per cell for larger electrodes. When loaded in the chamber they should fill a cell.

**FIG 1**

Vertical processing  
Hanging



Horizontal processing (top view)  
Nesting



## 5.2 Method 2- Micro-Section (validation method)

Micro sectioning can be used to validate the plasma results from Method 1 (weight loss).

Material: Glass reinforced epoxy or polyimide.

Size: 3" X 3" (76mm)

Layers: 8

Thickness: 0.062" +/- 0.010" (1.6mm)

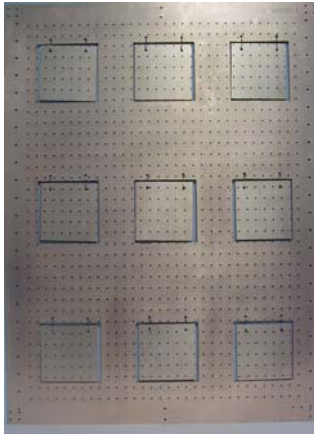
Hole Diameter: 0.032" (.81mm)

Quantity: 9 per carrier panel.

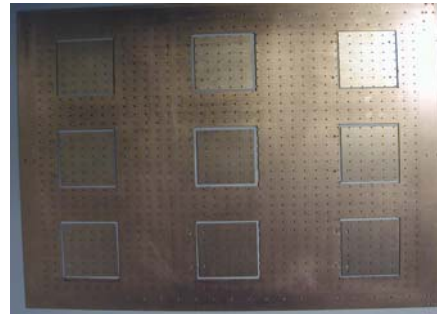
5.2.1 Loading: Load the samples the same as 5.1.1. (See Fig. 2)

**Fig 2**

Micro Section  
Hanging



Micro Section Nested  
Top View



## 6. PLASMA PROCESS

- 6.1 Process parameters: Process parameters are determined by the plasma manufacturer's procedures.
- 6.2 Chamber configuration: Carrier panels and dummy panels are placed in the plasma machine to represent a full load based on the manufacturer's instructions.

## 7. PROCEDURE FOR MEASURING THE UNIFORMITY

- 7.1 Weight loss (ref 3.1 equipment)
  - 7.1.1 Scribe a unique number on each sample.
  - 7.1.2 Using gloves to handle, weigh all the samples prior to loading on the carrier panels and record the measurements.
  - 7.1.3 Processing
    - 7.1.3.1 Vertical Processing: Hang the samples on the carrier panel so they can be identified as to the location in the plasma chamber. (ref 5.1) This should include the cell and position in the cell.
    - 7.1.3.2 Horizontal Processing: Lay the carrier panel in a cell and place a sample in each window. Identify the cell and position in the cell.
  - 7.1.4 Load the carrier panels in the first, center, and last cell of the chamber. Fill the remaining cells with dummy panels to create a full load. Process the panels (ref. 6.1-6.2).
  - 7.1.5 Remove the samples from the carrier panel and reweigh. Record the measurement next to the pre-plasma weights.  
NOTE: Reweigh the samples as soon as they are plasma processed to avoid any risk of moisture absorption.
  - 7.1.6 Calculating the uniformity  
The etch uniformity is based on the highest and lowest readings and an average of all the measurements, and its standard deviation. If the average is small relative to the sample range (maximum value minus the minimum value) then use the relative uniformity formula described in Section 4.5. Otherwise use the Percent Uniformity calculation described in Section 4.4.

Percent Uniformity Example:

Max = 20 $\mu$ m

Min = 15 $\mu$ m

Average = 18 $\mu$ m

27 Data Points

Percent Uniformity =  $1 - [(20-15) / (2*18)] = 86\%$  Uniformity

Relative Uniformity Example:

(NOTE: If Maximum minus Minimum is Close to Average. Need to Use Relative Uniformity)

Average = 1.60  $\mu$ m

Maximum = 2.2  $\mu$ m

Minimum = 1.1  $\mu$ m

Standard Deviation = 0.32

27 Data Points

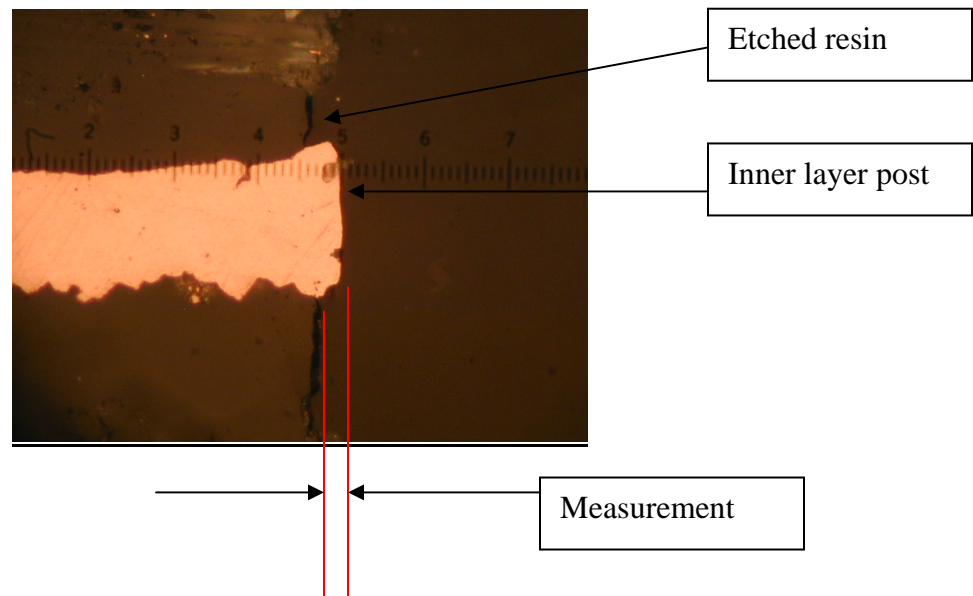
Relative Uniformity =  $(1.6/0.32) = 5$  (Good)

Percent Uniformity = 65% (Poor) – Incorrect Analysis!

## 7.2 Micro section (ref 3.2 equipment)

- 7.2.1 Because of the subjective nature of this analysis, prior to plasma processing, micro section one sample and evaluate. Any drill anomalies should be taken into consideration when evaluating the etch results and measurements.
- 7.2.2 Scribe each sample with a unique number.
- 7.2.3 Vertical Processing: Hang the samples on the carrier panel so they can be identified as to the location in the plasma chamber. (ref 5.1) This should include the cell and position in the cell.
- 7.2.4 Horizontal Processing: Lay the carrier panel in a cell and place a sample in each window. Identify the cell and position in the cell.
- 7.2.5 Load the chamber with the carrier panels and fill the remaining cells with dummy panels. Process the panels (ref. 6.1-6.2)
- 7.2.6 Remove the samples and micro section. Measure and record the amount of resin removed from each sample. When evaluating the micro sections the measurements are made at the inner layer post. (see fig 3)

Fig 3



- 7.2.7 The numbers recorded represent the etched resin and verify desmear or etchback in drilled through holes. Reference IPC 600 for acceptable guidelines.